Report Of Intermodulation Product Findings

KZCD 94.1 MHz. Lawton, OK.
KLAW 101.3 MHz. Lawton, OK.
KVRW 107.3 MHz. Lawton, OK.

Project# 25882

June 11, 2010

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Report of Findings for Intermodulation Product Measurements

Exhibits Accompanying This Report

REPORT OF FINDINGS
KZCD / KLAW / KVRW
94.1 MHz. / 101.3 MHz. / 107.3 MHz.

Introduction: This report of findings is based on data collected at the KZCD, KLAW and KVRW broadcast facility located in Lawton, Oklahoma. The report includes measurements offered as proof that the combined operations of KZCD (94.1 MHz.), KLAW (101.3 MHz.) and KVRW (107.3 MHz.) transmitters are in compliance with the FCC Rules and Regulations as required by the Code of Federal Regulations (CFR) Title 47 section 73.317 paragraph (b) through (d). In brief, the collection of measurements presented in this report shows that all possible third order inter-modulation (IM) products generated by this multiplexed system are less than the maximum allowable level as required by section 73.317 (b) through (d). Jeff Taylor of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on June 11, 2010.

The following exhibits are provided:

Exhibit A:
- A-1 Drawing Depicting Antenna.
- A-2 SHPX-10C6-SP Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexed Scheme.
- A-4 973-3 “Branch” Combiner Specification Sheet.
- A-5 Theoretical Vertical Plane Relative Field Antenna Plots

Exhibit B:
- B-1 Equipment Employed In Intermodulation Product Measurement.
- B-2 Broadcasting Scheme of the Multiplexed Systems.

Table 1. Carrier Reference Levels.
Table 2. Calculated Third Order Products.
Table 3. Intermodulation Analysis Measurements.

Exhibits Accompanying Report: Exhibit A provides comprehensive information on both antenna and filters used by these radio stations. Exhibit B illustrates the broadcasting scheme of each station, the layout of the equipment used to isolate and measure potential intermodulation products and forward carrier reference levels. Found within Table 1 are the narrow band carrier frequency measurements that provide relative output signal levels for the IM analysis. Table 2 lists the calculated third order products that can be generated from FM transmitters broadcasting from the multiplexed system. The IM Analysis Measurements, in Table 3, provides detailed information obtained from the product frequency investigation.

The Nature of Intermodulation Products (IM): Intermodulation products result from inadequate transmitter-to-transmitter isolation. Intermodulation products are commonly generated from radio stations operating into multiplexed facilities and congested antenna broadcast sites. The mechanics associated with the phenomenon have been well documented. When two or more transmitters are coupled to each other, new spectral components are produced by the mixing of the station frequencies in the active circuits of each transmitter. The common term used to describe this phenomenon is third order product denoted by the mathematical expression $[2(F_1)-(F_2)]$, where F_1 signifies the frequency of the transmitter that is generating the intermodulation product, and F2 signifies the frequency causing the interference.

The Multiplexed System: These measurements were taken with all FM stations operating from the combined antenna system. The KZCD, KLAW and KVRW multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-10C6-SP (antenna) and 973-3 “Branch” combiner units, and MACX 350 feedline are products of Electronics Research, Inc. while the Heliax (HJ11-50) is Andrew. Refer to Exhibit B-1, for an illustration of the Broadcasting Scheme of these stations.

To accomplish the aggregation of three transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of a 973-3 “Branch” Combiner, filter system was installed. Specifically, the combiner utilizes three ERI Model 973-3 modules for each frequency (94.1 MHz., 101.3 MHz. and 107.3 MHz.). Interconnecting “T’s” are required to complete the combiner which is illustrated in the attached Exhibit A-3. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -67 dB. Other performance measurements, such as match, loss, group-delay, etc, revealed that the multiplexer unit was in proper working condition. Refer to Exhibit A-4 for the Combiner Specification Sheet.

The IM Investigation: Directional Couplers were placed at key locations throughout the combiner to monitor and maintain the multiplexer’s performance. All couplers furnished with the system are factory calibrated and capable of delivering accurate and repeatable RF measurements. To facilitate the taking of the measurements, the coupler located at the antenna output of the multiplexed system was used. Care was taken in the selection of the measurement location to insure that the measurements would be made far removed from transmitters and any filtering used to reduce broadcast emissions. The coupler selected would normally be used for antenna reflection measurements and thus would provide greater than -30 dB directivity and a forward signal sample of -45 dB.

The forward port of the coupler was used for sampling the outgoing carrier levels and IM products. The IM sampled signal was fed by shielded cable into a Band Pass Filter where all extraneous energy was steeply attenuated. Various attenuation pads were used, when needed, on the band pass filter and/or the Spectrum Analyzer to ensure an adequate signal level for measurements without overloading the measurement equipment. A Rohde & Schwarz ZVL Vector Network Analyzer with Spectrum Analyzer serial# 100396 was employed to record the level of all signals investigated. The Rohde & Schwarz was also used for selective tuning of the Band Pass Filter. The Spectrum Analyzer portion of the Rohde & Schwarz was used to measure the close in spectral attenuation of each carrier and wide band search for any anomalies that may need further investigation. See attached Exhibit B-1 for an illustration of the measurement equipment.

Prior to recording measurements, all pertinent broadcasting equipment including Transmitters, Multiplexer, Feed Line and Antenna were adjusted to optimal performance. Also, it was confirmed before taking any measurements that all transmitters were operating at full licensed power. From the equipment setup described above, the relative output signal level of each stations forward carrier was made. The resulting signal levels of these measurements are listed in Table 1, column labeled "Adjusted Level". This level will be used as the reference level for possible IM products of each carrier and was necessary to confirm that no significant levels of spurious energy, referenced to each carrier, were present from any transmitter operating from the multiplexed system.

Table 1 - Carrier Reference Levels.

Carrier Frequency (MHz)	Pad One (dB)	Bandpass Filter Loss (dB)	Measured Level (dBm)	**Adjusted Level (dBm)**	Notes
KZCD 94.1	**20**	**-**	**-1.37**	**18.63**	
KLAW 101.3	**20**	**-**	**6.50**	**26.50**	
KVRW 107.3	**20**	**-**	**2.47**	**22.47**	

Predictable third-order products due to system harmonics mixed with all on-site interfering frequencies that could be generated from the multiplexed system are calculated and listed in Table 2.

Table 2 - Third order Products.

	Carrier Frequencies		
Interfering Frequencies	**94.1**	**101.3**	**107.3**
94.1 MHz.	----	108.5	120.5
101.3 MHz.	86.9	----	113.3
107.3 MHz.	80.9	95.3	----

Using the equipment previously described the IM product measurements were recorded and are listed in Table 3. The signal levels referenced to the carriers are calculated and listed in the column labeled "Level Referenced to Carrier". Refer to Exhibit B-2 for a layout of the measurement equipment.

Table 3 – Intermodulation Measurements

IM Measurements Taken in Lawton, OK.									
Product Frequency (MHz)	**Transmitter Frequency (MHz)**	**Interfering Frequency (MHz)**	**Pad (dB)**	**Bandpass Filter Loss (dB)**	**Total Loss**	**Measured Level (dBm)**	**Adjusted Level (dBm)**	**Carrier Reference Level (dBm)**	**Level Referenced to Carrier (dBm)**
Transmitter Mixes									
	94.1		20		20	-1.37	18.63	**18.63**	
	101.3		20		20	6.5	26.5	**26.5**	
	107.3		20		20	2.47	22.47	**22.47**	
80.9	94.1	107.3	3	10.2	13.2	-94.64	-81.44	18.63	**-100.07**
86.9	94.1	101.3	3	13.5	16.5	-95.06	-78.56	18.63	**-97.19**
95.3	101.3	107.3	3	14.2	17.2	-94.05	-76.85	26.5	**-103.35**
108.5	101.3	94.1	3	13.2	16.2	-91.57	-75.37	26.5	**-101.87**
113.3	107.3	101.3	3	13.7	16.7	-91.65	-74.95	22.47	**-97.42**
120.5	107.3	94.1	3	13.8	16.8	-96.4	-79.6	22.47	**-102.07**

The Spectrum Analyzer was used to check the close in spectral attenuation of the carrier to confirm the operation of the transmitter is in compliance with Sections (b) and (c) of the FCC Rules and Regulations.

As a final proof of the systems IM Product performance, a wide band search was undertaken using the Spectrum Analyzer. The purpose for this measurement was to look for suspicious anomalies that may warrant further investigation. My search ranged the complete frequency span of the receiver and resulted in no additional investigations.

Conclusion: Based upon my observations and measurements taken on June 11, 2010 as summarized in this document, I, Jeff Taylor, find the subject system, specifically the transmitter and filter system for the operation of KZCD, KLAW and KVRW into the antenna to be in proper working order. Furthermore, based on the measured data, it is my opinion that there are no inter-modulation products in excess of 80 dB below carrier levels generated from or within the station operating on the installed system. Based on this recorded data, I conclude that KZCD, KLAW and KVRW are in compliance with the requirements of Section 73.317 paragraph (b) through (d) of the FCC Rules and Regulations.

Respectfully submitted,
Electronics Research, Inc.

Jeff Taylor, Field Technician

State of Indiana)
) SS:
County of Warrick)

AFFIDAVIT

I, Jeff Taylor, hereby declare that the following statements are true and correct to the best of my knowledge and belief :

1.) I am a Field Technician for Electronics Research, Inc ("ERI ") and have been employed by ERI for 13 years. I am familiar with and have assisted in the design, manufacturing and installation of FM Antennas and FM Multiplexers in my long tenure with ERI.

2.) I have either prepared and/or directly supervised the preparation of all technical information contained in this Report of Findings and to my knowledge to be accurate and true.

3.) ERI has been requested by Gap Broadcasting on behalf of radio Stations KZCD, KLAW and KVRW in Lawton, OK. to prepare this Report Of Findings.

Jeff Taylor; Field Technician

Jeff Taylor

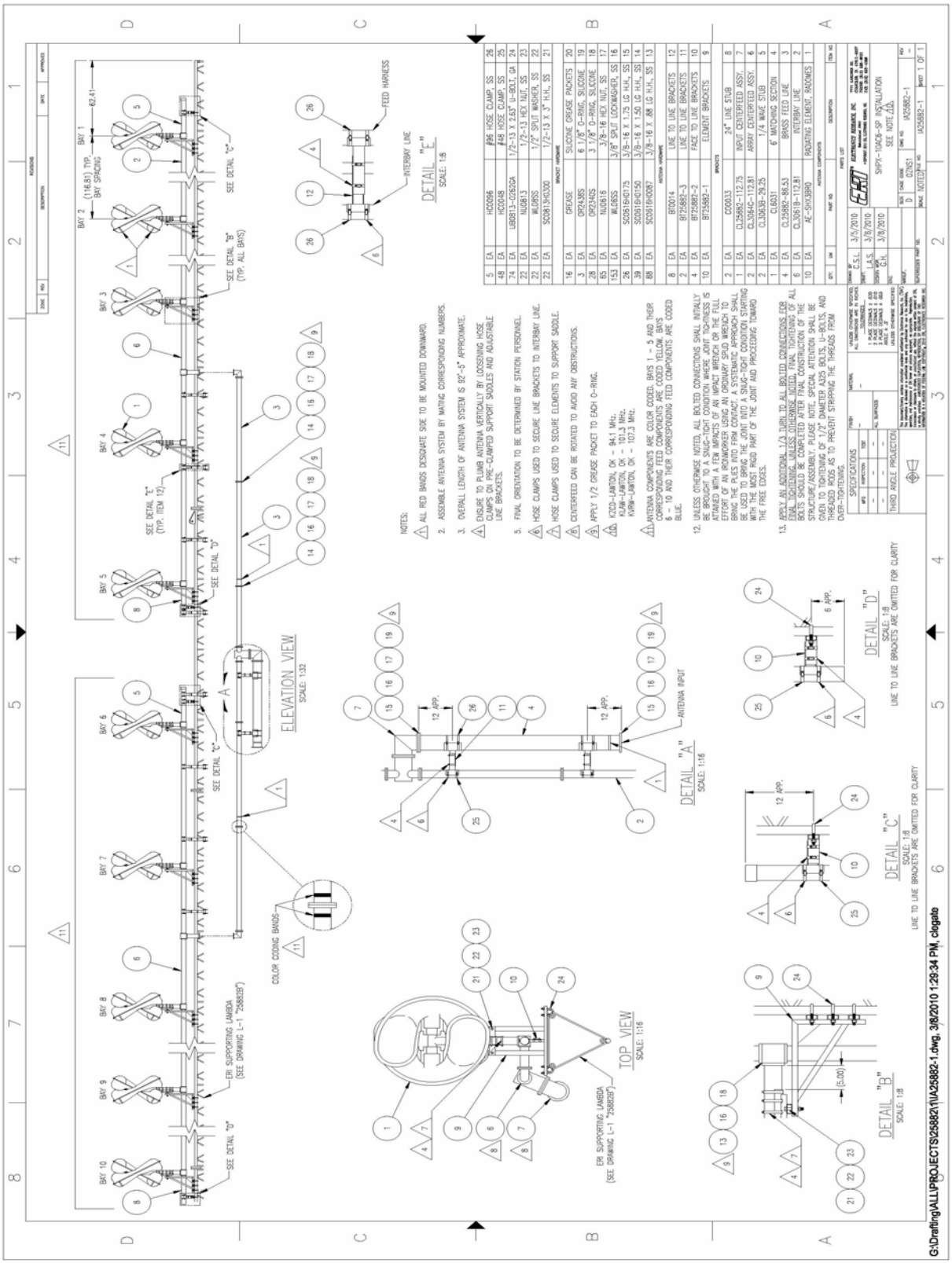
Subscribed and sworn to before me on this 14th, day of June, 2010.

Jacquelyn Kinney; Notary Public
My commission expires July 5, 2015

JACQUELYN S. KINNEY
Notary Public, State of Indiana
Vanderburgh County
My Commission Expires
July 05, 2015

Jacquelyn S. Kinney

EXHIBIT, A-1



A-2 ERI Antenna Specification Sheet

Lawton, OK.

General Specifications

Antenna Type . . . . . .High Power FM-Broadcast, Suitable For Multiplexing
Model Number SHPX-10C6-SP
Number of Bay Levels ..... Ten
Polarization .....Right Hand Circular

Electrical Specifications

Antenna Input Power Capability . . . . . 32 kW Max (1)
Operating Frequency Band ..... 94.1 ~ 101.3 ~ 107.3 Megahertz.
VSWR. . . . . <1.04:1 @ Operating Frequencies(2)
Azimuthal Pattern Circularity ..... Better Then +/- 1dB From RMS (Free Space)
Power Split ..... 50/50 (Horizontal & Vertical)
Frequency Specific Information:

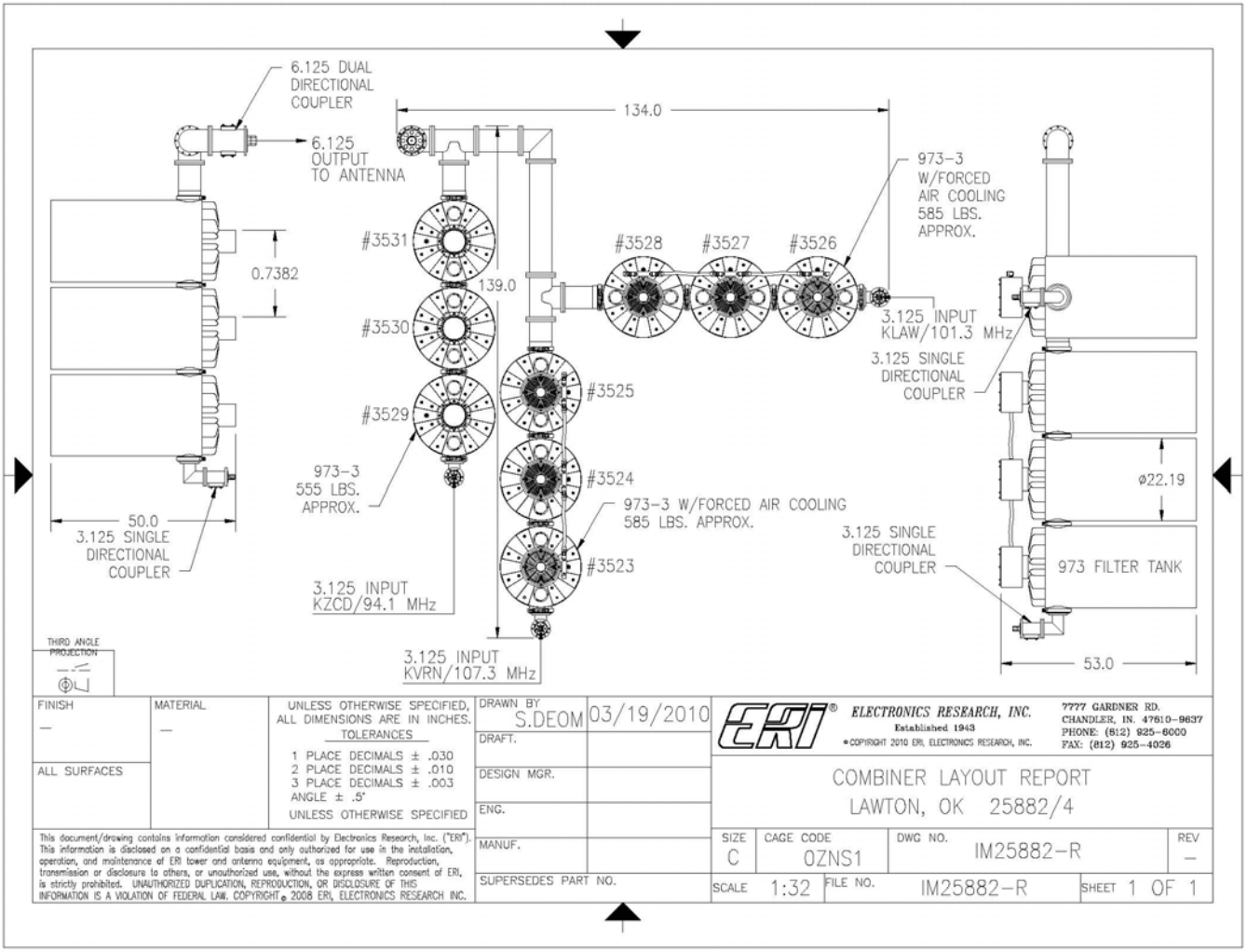
Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain	Line Loss (3)	Filter Loss (4)	Computed TPO
94.1	**16 KW**	**0°**	**13 %**	**15 %**	**4.992**	**-0.6022 dB**	**.138 dB**	**3.801 kW**
101.3	**100 KW**	**0°**	**1 %**	**2 %**	**5.652**	**-0.6237 dB**	**.140 dB**	**21.09 kW**
107.3	**26 KW**	**0°**	**13 %**	**16 %**	**4.723**	**-0.6450 dB**	**.157 dB**	**6.621 kW**

Mechanical Specifications

Antenna Feed System .....Fed With One 6 1/8” Line
Input Connector …… . 6 1/8”-50 Ohm EIA Flanged
Element Deicing.....Radomes
Interbay Spacing ..... 116.8125” Center to Center
Array Length..... 93 Feet
Construction Material (Antenna) ..... All Noncorrosive
Construction Material (Mounting) ..... All Stainless Steel

1) Power Capability Has Been Rated Assuming an Operating Transmission VSWR of 1.5:1
2) VSWR Specification Achieved After On Site Tuning For User Specific Frequencies.
3) Line Loss Assumes a Feed Run of 74.7 Feet, 3 1/8" ERI MACXLine (MACX350) and 478.4 Feet, HJ11-50 4” Andrew Heliax
4) Losses Taken From Actual Combiner.

EXHIBIT A-3



A-4 ERI Combiner Specification Sheet

Lawton, OK.

General Specifications:

Multiplexer Type ..... 973-3 "Branch" Combiner
Number of Combining Units ..... Three
Injected Port to Injected Port Isolation ..... < - 67 dB
Output Connector ..... 6 1/8 "50 Ohm EIA (Flanged)
Output Power (Designed) ..... 32 kW(1)

Heat Removal .....Forced Air Cooling
Physical Arrangement .....Floor Standing

Injected Port Specifications:

Frequency Assignment .....94.1, 101.3 and 107.3 MHz.
Power Rating, Each Injected Port (Designed).....8.195 kW for 94.1 MHz.
Power Rating, Each Injected Port (Designed).....21.09 kW for 101.3 MHz.
Power Rating, Each Injected Port (Designed).....6.621 kW for 107.3 MHz.
Input Connector .....3-1/8" 50 Ohm EIA (Flanged).
VSWR.....< 1.07:1 @ +/-200 KHz.(2)
Group Delay .....Less than 50 ns Overall Variation, Carrier @ +/- 150 KHz.
Insertion Loss (Measured):

94.1 MHz. ..... - 0.138 dB
101.3 MHz. ..... - 0.140 dB
107.3 MHz. ..... - 0.157 dB

1) Power Rating Listed is as Designed Only. Actual Power Capabilities May Vary.
2) When Terminated in 50 Ohm Resistive Load.

EXHIBIT A – 5

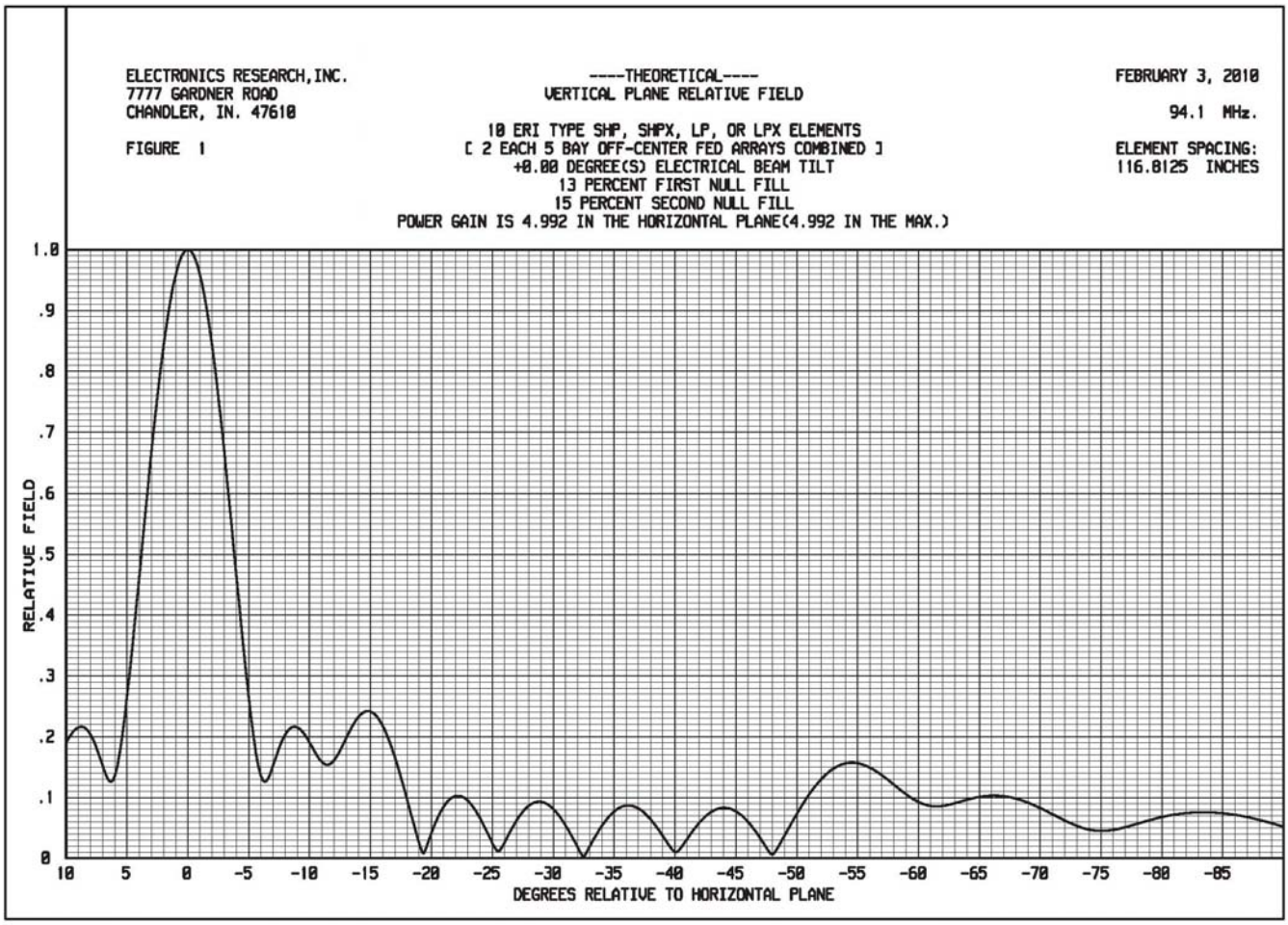

ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 1
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
10 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
[2 EACH 5 BAY OFF-CENTER FED ARRAYS COMBINED]
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
13 PERCENT FIRST NULL FILL
15 PERCENT SECOND NULL FILL
POWER GAIN IS 4.992 IN THE HORIZONTAL PLANE(4.992 IN THE MAX.)
FEBRUARY 3, 2010
94.1 MHz.
ELEMENT SPACING:
116.8125 INCHES
RELATIVE FIELD
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85
DEGREES RELATIVE TO HORIZONTAL PLANE

EXHIBIT A – 5

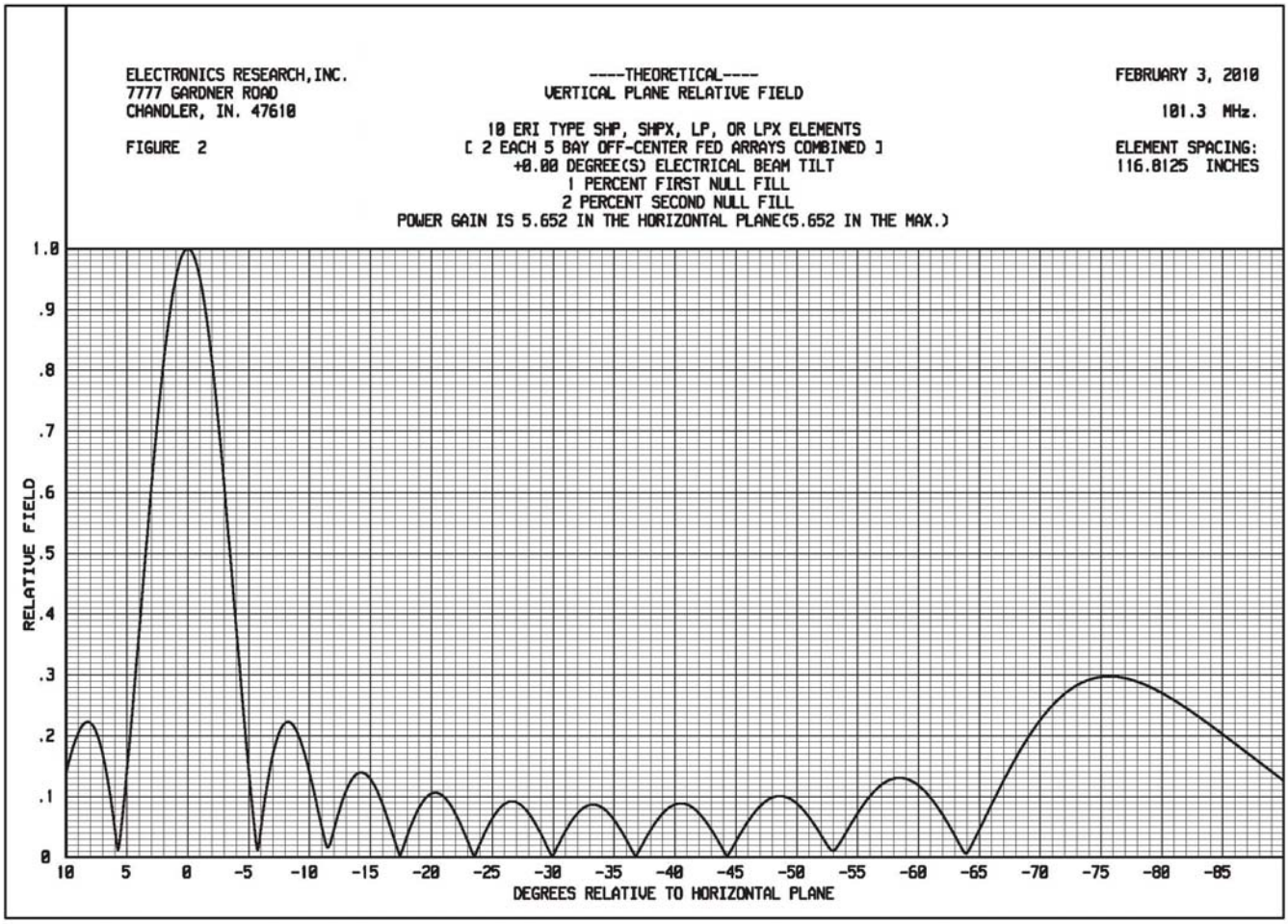
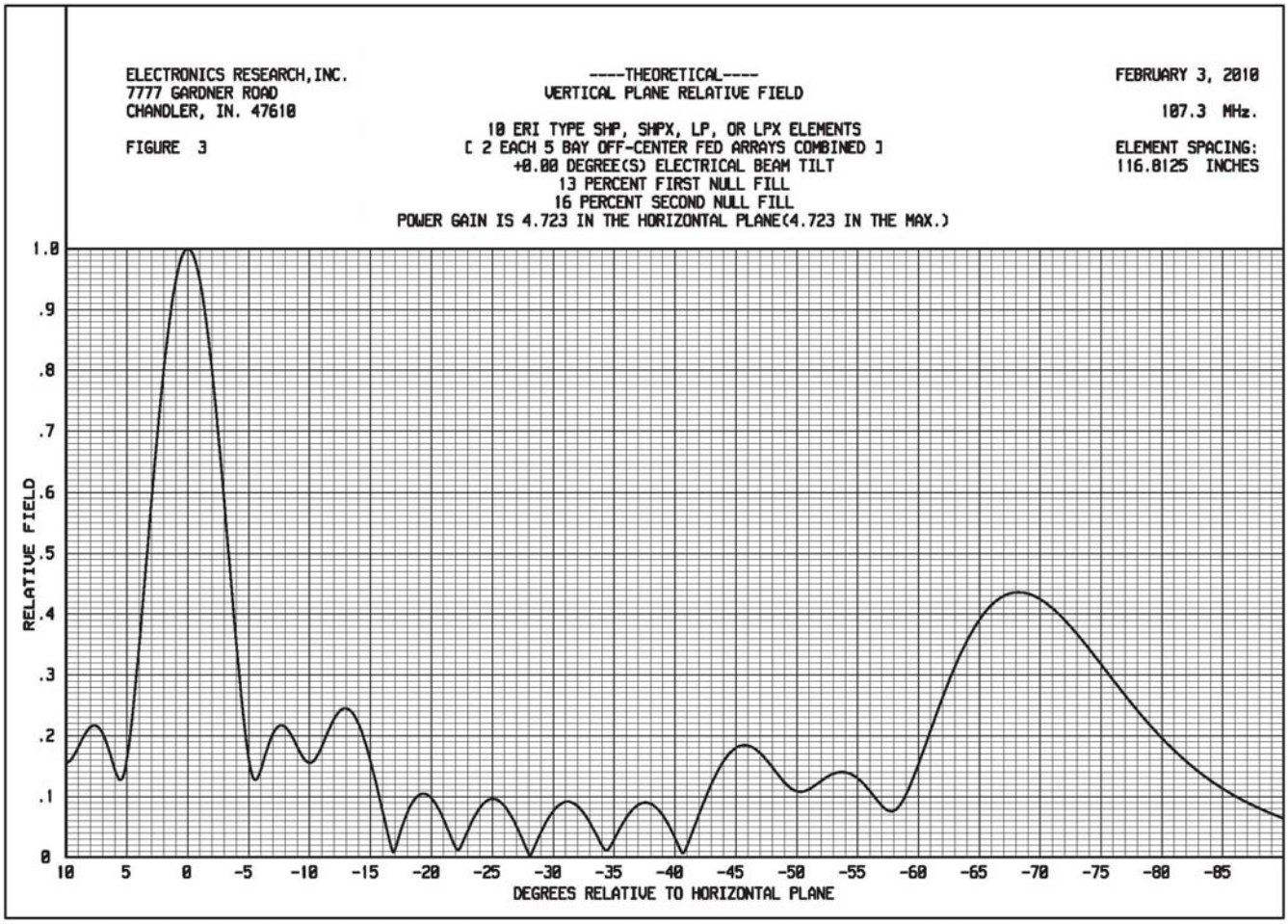
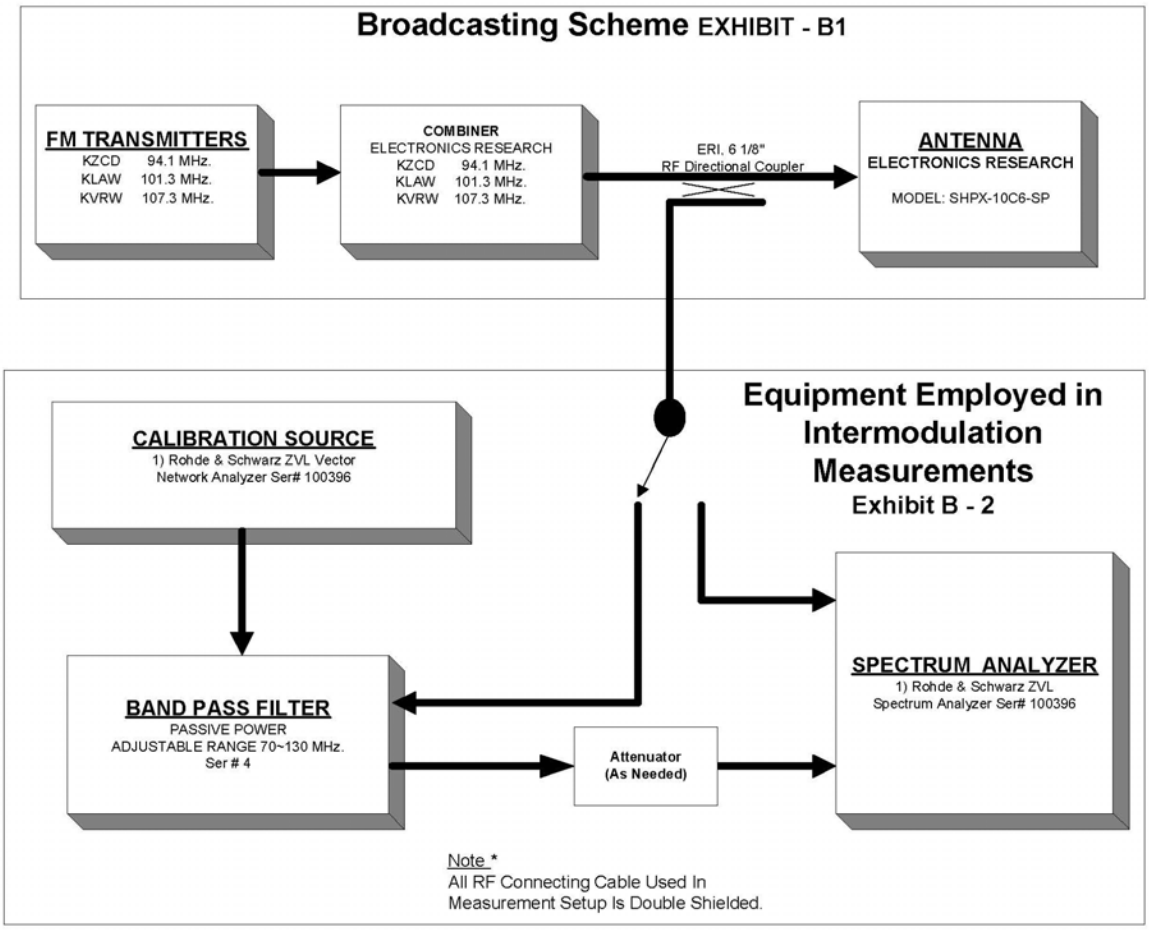

ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 2
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
10 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
[2 EACH 5 BAY OFF-CENTER FED ARRAYS COMBINED]
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
1 PERCENT FIRST NULL FILL
2 PERCENT SECOND NULL FILL
POWER GAIN IS 5.652 IN THE HORIZONTAL PLANE(5.652 IN THE MAX.)
FEBRUARY 3, 2010
101.3 MHz.
ELEMENT SPACING:
116.8125 INCHES
RELATIVE FIELD
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85
DEGREES RELATIVE TO HORIZONTAL PLANE

EXHIBIT A – 5


ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 3
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
10 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
[2 EACH 5 BAY OFF-CENTER FED ARRAYS COMBINED]
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
13 PERCENT FIRST NULL FILL
16 PERCENT SECOND NULL FILL
POWER GAIN IS 4.723 IN THE HORIZONTAL PLANE(4.723 IN THE MAX.)
FEBRUARY 3, 2010
107.3 MHz.
ELEMENT SPACING:
116.8125 INCHES
RELATIVE FIELD
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85
DEGREES RELATIVE TO HORIZONTAL PLANE



Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

EXHIBIT B